DOCUMENT RESUME

ED 247 708 EC 170 063

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TITLE Development of Perceptual Processes and Problem-Solving Activities in Normal, Hearing-Impaired, and Language-Disturbed Children: A Comparison Study Based on Piaget's Conceptual Framework.
PUB DATE Jun 84
NOTE 17p.; Contained in: International Symposium on Cognition, Education, and Deafness (Washington, DC, June 5-8, 1984). Working Papers. Volumes I and II. David S. Martin, Ed.
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Age Differences; Cognitive Development; Elementary Education; *Hearing Impairments; *Language Handicaps; Learning Problems; Multiple Disabilities; *Perceptual Development; *Problem Solving; Young Children

ABSTRACT

A longitudinal study followed perceptual and problem solving skill development in children (2-11 years old) with severe problems of oral and written language acquisition: 15 hearing impaired (HI) Ss; 11 children with a hearing loss that alone did not account for their language problem, who presented in addition so-called "learning problems" (HIL group); and the children with normal hearing and no motor disability or retardation that would account for the language problems (L group). Data indicated that HI Ss developed like normal controls in nonverbal developmental performance which did not include the use of auditory communication. In tasks of successive pattern recognition and form recognition, normal Ss improved from 3-14 years for both tasks. HI Ss performed like the normal Ss except for poorer scores on the most complex successive patterns at older ages. Modality condition effects were observable in HIL and L Ss, confirming the original criteria for forming the three subgroups: forms were recognized better in the visual, but not the tactile condition of tactile-visual one at all age levels. Complex successive patterns were failed in all modality conditions. Seriation problems were presented under different modality conditions: visual, visual-tactile, and tactile. An increase in task success was found in normal and HI Ss, 3-12 years old, and modality condition affected performance. Analysis of problem solving activities revealed an increase with age in normal and HI children, except for HI Ss at young age who showed lower performance in evaluative activities. (Author/CL)

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ED247708

DEVELOPMENT OF PERCEPTUAL PROCESSES AND PROBLEM-SOLVING ACTIVITIES IN NORMAL, HEARING-IMPAIRED, AND LANGUAGE-DISTURBED CHILDREN: A COMPARISON STUDY BASED ON PIAGET'S CONCEPTUAL FRAMEWORK

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Abstract

A longitudinal study was started in 1970 with the financial support of the Swiss National Science Foundation. Subjects were children who presented severe problems of oral and written language acquisition: Hearing-impaired children with a loss so severe that it accounted for their language delay (HI group); children with a hearing loss that alone did not account for their language problem, who presented in addition so called "learning problems" (HIL group); and children with hearing within normal limits, and no motor or mental retardation that would account for their language problems (L group).

Longitudinal data collected over 10 years indicated that HI children developed like normal controls in non-verbal developmental performance which did not include the use of auditory communication. The cross-sectional studies included Successive Pattern Recognition and Form Recognition in normal, hearing-impaired children without specific learning problems (HI group) and with learning problems (HIL group), and hearing children with learning problems (L group). Performance of normal children improved from 3 to 14 years for both tasks. HI children performed like the normal children except for poorer scores on the most complex successive patterns at older ages. Modality condition effects were observable in the HIL and L children confirming the original criteria for forming the three subgroups: forms were recognized in the visual, but not in the tactile condition or tactile-visual one at age levels. Complex successive patterns were failed in all modality conditions.

Seriation problems (Piaget, 1956) were presented under different modality conditions: visual, visual-tactile, and tactile. An increase in task success was found in normal and HI children, 3 to 12 years old, and modality condition affected performance. The Pitt and Brouwer-Janse's model of problem solving was applied to analyze the activities of the children. There was an increase with age in normal and HI children, except for HI children at young age who showed lower performance in evaluative activities.

A model of learning has been described based on the findings of longitudinal studies, and experimental investigations.

Acknowledgements

The support of these investigations by the grants Nr. 3.237.69, 3.448.70, 3.902.72, 3.2050.73, 3.504.75, 3.711.76 and 3.929-0.78 of the SWISS NATIONAL SCIENCE FOUNDATION is gratefully acknowledged.

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Introduction

Language as a conventional system of signs is not the cause of the appearance of representation and not necessary for the development of thinking. Extensive research data on the development of the normal child, comparisons among hearing, deaf, and blind children and the observations of language-disturbed persons support such an assumption (Affolter, 1968).

This assumption raises the question about prerequisites for language acquisition and for cognitive development.

1) Cross-sectional studies indicate that language-disturbed children fail in different perceptual processes. This finding suggests that their linguistic failures are related to perceptual problems. Similar perceptual problems were observable in hearing-impaired children with so-called specific learning problems not accounted for by their hearing loss.

2) Longitudinal studies of the same language-disturbed children with or without hearing loss showed no direct relationship between their failure in language acquisition, failures in non-verbal performances, and failure in perceptual processes. Their failures appeared to be related to difficulties in interaction in the form of problem-solving tasks in daily life activities. These difficulties seemed to include difficulties in exploratory processes but not in hypothetic cognitive processes; this point suggests, furthermore, that these children are not simply retarded but deviant in development.

3) These findings and assumptions have implications for educational practice:

- Working with hearing-impaired children with learning problems, one must consider the possibility that they fail in other perceptual processes, in addition to their hearing impairment.

- The teaching of language as well as cognitive non-verbal performances and perceptual processes to these children must include (a) basic interaction experiences of a 'problem-solving kind,' and (b) special help in exploratory activities (Affolter & Stricker, 1980).

The Problem of Prerequisites

The present report is based on a longitudinal study which began in 1970 under the auspices of the Swiss National Science Foundation including 72 children, 2 to 11;11 years old, with severe problems in oral and written language.

Longitudinal Observations

The participants fell into three categories. First, were 15 hearing-impaired children with sufficient hearing loss to account for their delay in acquiring language; these children, essentially normal except for their hearing impairment, will be called the HI group. The second group was composed of 11 hearing-impaired children with severe language problems not accounted for by their hearing loss. They did not progress in a program for hearing-impaired as was expected. When tested on the Snijders-Oomen-Non-verbal-Intelligence scale (1964), they scored at age level on sorting tasks, but failed in picture recognition. They also failed in complex movements as measured by the Lincoln-Oseretzky scale (Eggert, 1971); they will be termed the HIL group. A third group included 46 children with severe language problems not accounted for by any significant hearing impairment, motor retardation, or mental retardation; these children were considered to be learning-disabled and are designated the L group. The L group included some children who were considered 'autistic' as well as some who were labelled as dyslexic. The HIL and L groups will also be referred as the "clinical group."

In a first report (Affolter, et al., 1974) 30 of the clinical children, 3 to 10 years old, were compared to 30 normal children. Of the 30 clinical children, 11 had a severe hearing loss and made up the HIL group. Criteria for 'severe hearing loss' was 60 dB HL (ref: ANSI) or greater in the better ear (three-frequency pure-tone-average). A second report (SNF 3.237.69; 3.448.70; 3.902.72; 3.2050.73) included another group of 15 HI children.

The children were observed on numerous performances. Standardized testing procedures were administered whenever available to children who were considered testable. Observations were made: (1) on input of visual, auditory, and tactile-kinesthetic stimuli; (2) on general behavior such as motor skills, attention span, anticipatory performances, eye contact, hand-eye coordination, body-eye coordination, and shifting behavior (stereotype movements); and (3) on elaborative performances according to Piaget's different levels of intelligence, such as direct imitation for sensory-motor intelligence, deferred imitation for intuitive intelligence, figurative and operative performances (such as drawing and symbolic play for pre-operative intelligence), and sorting and seriation skills for concrete intelligence.

The following results were found:

(1) L children without a hearing loss and HIL children with additional learning problems differed from normal and H children not only on the basis of their specific language problems, but also on the basis of their disturbances in non-verbal general behavior and elaborative performances: they all failed in complex motor skills, in eye contact, hand-eye coordination, in imitation of gestures, in symbolic non-verbal play behavior, and in drawing and recognition of pictures. They also failed in the recognition of successive patterns in the different modality conditions of auditory, visual, and vibro-tactile. These

failures point to a disturbancy that is primary to language acquisition and affects sensory-motor performances in Piagetian sense. Modality-specific input functions were not found to be an adequate basis upon which to distinguish the clinical from the normal group. The difficulties in general behavior and elaborative performances were found in L children without a hearing loss as well as in HIL children with a hearing loss.

(2) The clinical group appeared to be a heterogeneous group: both the L group and the HIL group children fell into three discriminable subgroups. The first subgroup was characterized by the difficulties in responding to situations which required the integration of tactile-kinesthetic information. The second subgroup characteristically had difficulty in processing information from two disparate modalities simultaneously, for example, tactile and visual input, or auditory and visual input. For example, they failed in localizing adequately visual-auditory, as well as visual-tactile-kinesthetic stimuli. This subgroup of children with intermodal processing deficits included most of the children diagnosed as autistic. A third subgroup of children with learning problems was characterized by difficulty in handling problems involving sequences of events, actions, or stimuli. In summary, learning difficulties appeared to be of three kinds: (a) integrating tactile-kinesthetic information; (b) simultaneous processing of intermodal input; (c) sequencing of events or stimuli. Based on these findings, the hypothesis was advanced that a critical amount of tactile-kinesthetic information-processing and of intermodality connection are necessary for imitation, for symbolic non-verbal processes, and for language acquisition. A critical amount of sequential integration is a prerequisite for direct imitation and speech-sound development.

Longitudinal observations over the 10 years of study revealed that the HI children developed similarly to normal, hearing control subjects in respect to non-verbal performances not dependent on auditory communication. The cognitive developmental patterns of the other two groups, the L group and the HIL group, however, differed substantially from the normal control group (SNF projects: 3.237.69, 3.448.70, 3.902.72, 3.2050.73, 3.504.75, 3.711.76; Affolter & Stricker, 1980).

Cross-Sectional Experimental Studies

Cross-sectional experimental studies investigated the following hypothesis: perceptual processes develop in the normal child over the entire period of language acquisition; children with severe language disturbances, including deaf children with specific learning problems, will fail in perceptual processes of a more complex kind.

Two experiments were designed which utilized non-verbal instructions: a successive pattern-recognition task and a form-recognition task.

Successive Pattern Recognition (SPR) in normal, HI, HIL, and L children. Non-verbal test items consisted of a standard and a comparison pattern and were presented in the visual, auditory, and vibro-tactile modalities. Subjects judged whether the standard and the comparison patterns, presented consecutively, were the same or different. In Series 1, patterns included only single elements, in Series 2 two elements, in Series 3 and 4, three and four elements, respectively. Stimulus elements were presented for 500 msec and were separated by 500 msec. The standard and comparison patterns were separated by an interval of 2 sec and 5 sec elapsed between presentation items. In a test item, elements varied in two dimensions, intensity and frequency, or site of stimulation, in the case of vibro-tactile patterns.

Acoustic patterns included pure tones of two frequencies, 500 and 1000 Hz, at two intensity levels differing by 10 dB. Acoustic patterns recorded from a master tape were presented via a speaker from about 60 cm behind the seated subject. Sensation level for the less intense tones was set at 30-45 dB based on calibration tones used to assess individual thresholds. Optic patterns were red and green color, dim and bright intensity. A color filmstrip of the optic patterns was projected on a screen about 1.2 m in front of the subject; images were about 6 x 10 cm. Intensity contrasts were easily discernible. Vibro-tactile patterns were produced at 125 Hz at two intensity levels differing by 6 dB presented at two places. Patterns were presented a via two-bone conduction receivers of the type used in audiometry (Radioear B 70) which were held firmly in place on the right middle finger and thumb, flush with the finger tip. The more intense stimulus had an estimated force of 6000 dynes, or 10-20 dB above estimated threshold. The right hand was positioned palm-down with vibrators free of contact with other surfaces. Stimuli were not audible.

In a pilot study, 21 HI children's performance on visual and auditory tasks were compared to that of 33 normal children. Age range was 4 to 10 years (Affolter, 1970).

In consecutive studies, 240 normal children, 36 HI children, 9 HIL children and 88 L children were examined on vibro-tactile pattern-recognition in addition to the visual and auditory tasks. Age range was 4 to 14 years (Affolter & Stricker, 1980).

The systematic score increases of normal and HI children with age suggested that non-verbal successive pattern-recognition undergoes a long development during a time period similar to that reported for language acquisition (Palermo & Molfese, 1972).

Successive pattern-recognition was influenced by modality of presentation and stimulus complexity in ranked order of decreasing number of correct responses: visual, auditory, vibro-tactile modalities (Series I, II, III, IV).

HI group children performed equal to or better than normal children in vibro-tactile and visual Series I at all ages. However, in Series III and IV, scores were depressed in all modalities and at all ages.

HIL and L group children performed more poorly than normal and HI children in all series of all modalities. When their performance was comparable to normal, it occurred only on visual and vibro-tactile Series I after considerable age delay.

Form Recognition in normal, HI, HIL and L children. In a pilot study 12 deaf children were compared to 18 normal children on several Piagetian tasks, among them a form-recognition task, called 'stereognostic task' which included a Series I with topological forms, a Series II with simple Euclidian, a Series III with complex Euclidian forms (Affolter, 1954; Piaget & Inhelder, 1948, 1956).

That method of the stereognostic task was changed in 1974 into a 'problem-solving task' not involving any instruction by verbal signs or gestures so that it could be applied to severely language-disturbed subjects. Two other conditions were added to the visual-tactile modality condition originally utilized: a visual-visual and a tactile-tactile condition (Affolter & Stricker, 1980).

This method was applied to 140 normal children, 3 to 9 years old. Results showed age and modality effects in the expected direction: improvement with age, highest scores in the visual, lowest in the tactile condition. Series effect was related to increased difficulty in recognizing complex Euclidian forms. Cross-modal transfer was evident, especially in the effect of test order on tactile performance, which improved with prior visual experience at older ages. It is

suggested that tactile performance under this condition included intermodal features.

The 1974 study was followed by another study which included most subjects of the longitudinal research group: 13 HI, 4;9 to 11;11 years; 11 HIL, 5;1 to 14;9 years and 27 L children, 5 to 13;1 years.

The HI, HIL, and L children performed like normal children in that scores on visual form-recognition tasks were higher than on visual-tactile and tactile tasks. Normal and HI children were generally more successful than L and HIL children in all series and in each modality condition. The high frequency of inappropriate responses in the visual-tactile and tactile tasks of the L and HIL children suggests that these children have perceptual problems affecting form-recognition especially in the visual-tactile and tactile modality conditions.

In summary, three kinds of findings of the described studies are of special interest: (1) clinical children failed in sensory-motor performances, mainly in prelinguistic perceptual processes of a tactile-kinesthetic or an intermodal and a sequential nature. (2) Such perceptual processes undergo a long development. (3) Longitudinal developmental changes appeared to differentiate clinical from normal children, and within the clinical group the three subgroups were discriminable.

Assumption About the Development of Prerequisites

The third kind of findings have an important impact for the assumption about the development of prerequisites: Longitudinal findings contradicted a direct relationship between the failures of the HI, the HIL, and L children in perceptual processes and their difficulties in language acquisition (SNF project: 3.929-0.78).

Thus, perceptual processes and sensory-motor performances cannot be considered as prerequisites. The results indicated, however, that all of the HIL and L children had difficulties whenever daily life presented problems which had

to be solved. In their daily activities they were able to choose problems; they were goal-oriented. But only seldom could they solve the problems, showing high levels of frustration.

Observations of normal children at different ages underlined that problem-solving activities develop and that daily interaction with the environment takes the form of such activity. Interaction, according to Piaget (1960), is the source of development. Therefore, it was assumed that by solving problems through daily activities (1) the child becomes increasingly more adequate in solving problems, (2) perceptual processes develop, (3) simple, later more complex performances of a sensory-motor level appear, followed by performances of intuitive and concrete intelligence. This sequence was assumed for performances of a non-verbal and verbal nature.

As a consequence, experience based on interaction with the environment in form of problem-solving can be considered to be the fundamental prerequisite for the development of perceptual processes and for language.

This point was assumed to be valid for the normal, for the HI child, and also for the language-disturbed child without or with a hearing loss. It was hypothesized that the perceptual deficiency of the L and HIL children causes their failures in adequate interaction with the environment. Consequently, they fail in acquiring a critical amount of interaction experience. Thus, they fail in developing more complex perceptual performances and language.

To investigate the development of problem-solving activities in normal and HI children and to evaluate the kind of failures of the L and HIL children, the following experiment was designed:

Seriation performances in normal, HI, HIL, and L children. For the new experiment a seriation task was chosen which was part of the pilot study with

Piagetian tasks (Affolter, 1954). That pilot study showed that HI children performed like normal children when constructing series. That seriation task was now changed into a non-verbal problem-solving task. It required the construction of a small and a large series of sticks differing in size, and presented under three modality conditions: visual, visual-tactile, and tactile.

The model applied (Brouwer, 1983; Pitt, 1983) provided for the description and analysis of behavioral changes in the sense of sequences of activities observable at two levels: (1) elementary component processes or subroutines, and (2) grouping of subroutines that function in concert as subprocesses for processing information and generating and testing hypotheses.

The elementary processes represented in the model are 25 empirically discriminable subroutines addressing such functions as lists given information. lists possible questions, assigns priorities, organizes data, etc. The elementary subroutines are grouped into eight subprocesses which address the following functions: basics, evaluatives, selectives, feedback, hypothetics, patterning, actions, and conclusions.

Subjects were 200 normal children, 3 to 13 years, 18 HI children, 3;2 to 12 years, 9 HIL children, 6 to 11;7, and 42 L children, 4;3 to 19;8.

An increase in task success with age was found in normal and HI children. The analysis of elementary subroutines and of subprocesses is in progress. Preliminary results corroborate:

(1) There are <u>developmental changes</u> in normal and HI children:

- younger children cannot solve the tasks because they lag in elementary component processes,
- with increasing age they become more competent; their subprocesses include more subroutines.

(2) Clinical children differ from normal and HI children in performance (task success), but not in competence (underlying cognitive structure):

- clinical children differ from normal and HI children in the sequence of task success; within the HIL and L group, subgroups are discriminable.
- clinical children differ from young normal children in the amount of overall subroutines they utilize; no subgroups are discriminable, neither in the HIL nor in the L group.
- clinical children differ from normal and HI children in the amount of subroutines they utilize in different subprocesses for different tasks; within the HIL and L group, subgroups are discriminable.

The preliminary findings can be interpreted as follows: Task success was low even in older clinical children. This finding underlines their failures in performance. Compared on task success, they were like the young normal and HI children.

However, compared with normal and HI children on their competence, they were more like older children; they showed a higher amount of overall subroutines than the normal and HI children at younger ages. Thus, the hypothesis about the difficulties of the clinical children in performance but not in competence appeared to be confirmed.

Success and the amount of subroutines in different subprocesses utilized by the clinical children seemed to depend on task conditions too, but again in a different way than in normal and HI children.

In summary, this finding suggests that clinical children have more difficulty in extracting information in specific task conditions than normal and HI children.

Difficulties of exploratory processes seemed characteristic of clinical children. They did not appear to have specific difficulties in hypothetic or feedback processes.

Such findings have specific implications for teaching.

Implications for Teaching Hearing-Impaired Children

The findings underline the importance of interaction with the environment. Such interaction in the form of problem-solving tasks must be the basis for working with HI and with HIL children. Teaching language and cognitive skills must be embedded in daily life activities. Audiovisual methods can only be utilized in connection with such daily life experience, and not substituting for them (Affolter, 1974).

In working with HI children, one must consider the possibility that some of them may have additional perceptual problems and that they belong to the described group of HIL children. It has to be expected that these children fail in interacting adequately with the environment and consequently lag in critical experience. These children have to be clearly identified.

HIL children need special help. Our observations underline their failures in adequate exploration of information inherent in a given situation. The enhancement of exploratory activities has to be focused when planning for and working with these children. For this purpose, a method of 'guiding' has been developed at the Center for Perceptual Disturbances in St. Gallen, Switzerland: Whoever is taking care of the child, the mother, the therapist, the teacher, etc., also takes the hands of the child, or his body, and explores with him a problem situation. The model for such 'guided exploratory activities' has been carefully designed during recent years and is still in progress. The model is based on extensive

observations of problem-solving activities of normal babies, infants, and older children (Affolter & Stricker, 1980; Affolter, 1981). Longitudinal studies are now in progress to evaluate the development of HIL and L children who participate in such a program.

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Working Paper presented

at the

International Symposium

on

Cognition, Education, and Deafness

Gallaudet College, Washington, DC, June 5-8, 1984